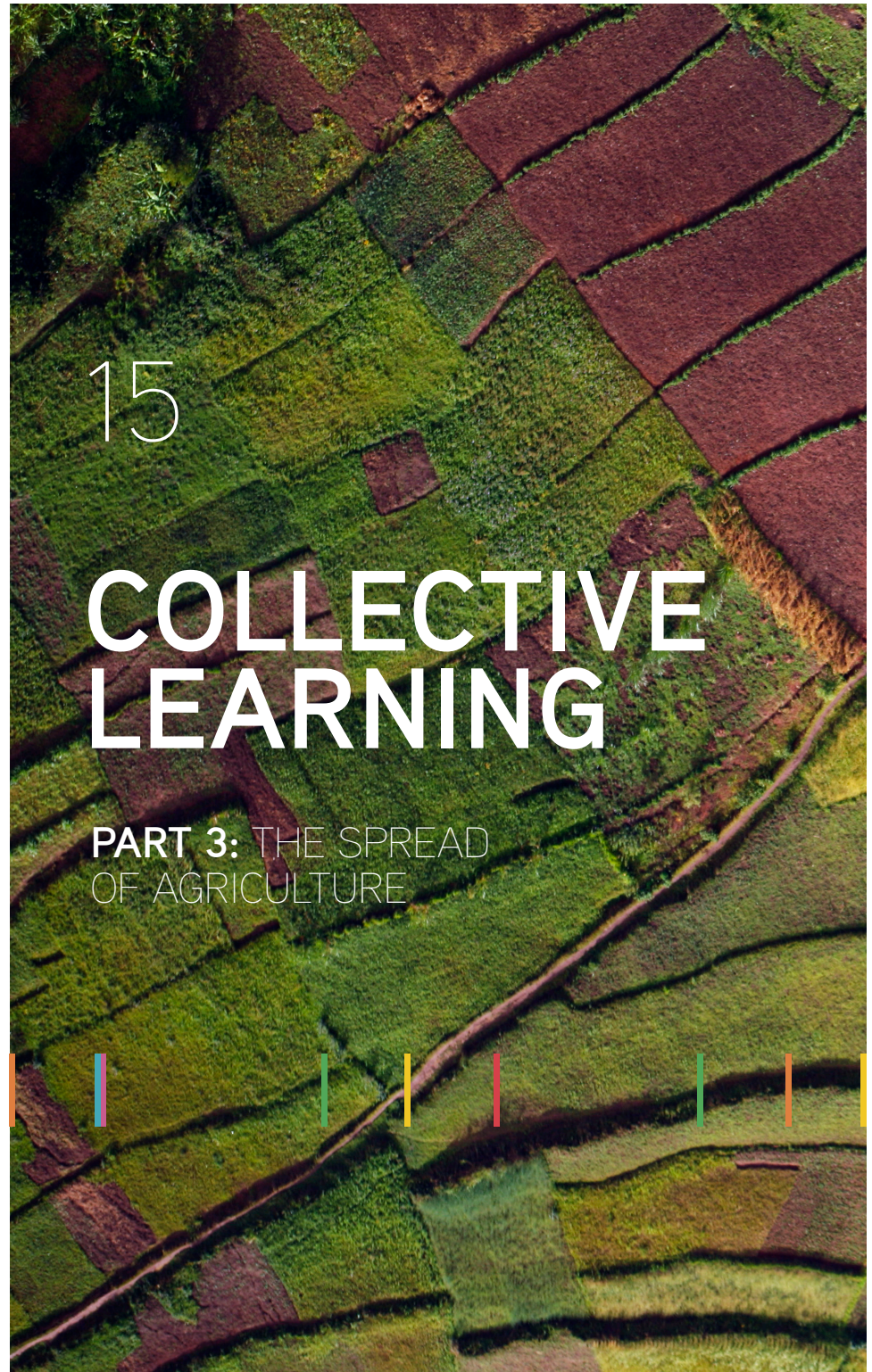


15

# COLLECTIVE LEARNING

PART 3: THE SPREAD  
OF AGRICULTURE

BIG HISTORY PROJECT



# COLLECTIVE LEARNING

UNIT 15

By David Christian

## How collective learning helped agriculture spread and improve

When agriculture appeared history seemed to speed up. We can see this in the growth and spread of human populations from the core areas where agriculture began. Five thousand years after the appearance of agriculture, the number of humans had increased by almost 10 times, from just a few million to almost 50 million. Such rapid growth was made possible by an increase in the number of innovations. Farmers spread into wooded zones, and semi-arid zones, learning new farming techniques as they moved; they developed new crops; designed new types of buildings; learned to domesticate animals in new ways; pioneered new ways of using clay and metals; and began to develop simple forms of irrigation.

Of course, some information was also lost. Farmers didn't need all of the information that foragers needed about how to use wild plants or herbs or animals. But now, in different parts of the world, you could find foragers' knowledge as well as farmers' knowledge, so there can be little doubt that the total amount of knowledge available to humans increased as farming spread in different parts of the world. New information and technologies and ideas appeared faster than old ideas were lost.

## When agriculture appeared, history seemed to speed up

Why does collective learning seem to operate faster and more powerfully in the agrarian era? Why does innovation seem to happen at warp speed today? To answer these questions we need to look more carefully at how collective learning works.

## How does collective learning work?

There are some basic rules about how collective learning works. Knowing these rules will help us think more clearly about how collective learning operated in different societies, different eras and different environments. Some of these rules will help us better understand why agriculture had such a profound impact on human history. To be precise we should describe these not as 'rules' but as statistical trends. Unlike the 'rules' of mathematics, they do not always work, but they do work a lot of the time. They are easy to see at very large scales, but when we study history at smaller scales they often seem to stall and sometimes even to go into reverse. Still, they are powerful enough that they may help us explain many features of human history.

## Studying networks

To understand how collective learning works we need to think about how humans exchange ideas. When several individuals are linked they form a "network," just as linked computers form the network that we call the Internet. Networks appear in many different forms. The Internet is a network of computers; economies are networks of individuals who are buying and selling goods and services; proteins within a cell form networks linked by different chemical reactions; the electricity grid is a network. Recent research suggests that all these networks share some important features. [For a good simple introduction to the theory of networks by one of the pioneers in the field, see Albert-Laszlo Barabasi, *Linked: The New Science of Networks*, Cambridge, Mass.: Perseus Publishing, 2002.]

All networks contain two main kinds of things: points and links between the points. Mathematicians call the points "nodes," and they call the links between the points "edges." So you could think of yourself and your best friends as nodes and the links between you as edges.

## Size matters!

It may seem obvious that more ideas can be exchanged if there are more people. But there is more to size than this. As ideas are shared they often change in subtle ways so the act of sharing alone can add new information. Think of how a story you told gets changed when your friend tells it!

In addition, the sheer number of possible exchanges increases very fast as the number of people rises. This is not hard to see even if you're not great at math. How many possible links are there between three friends? The answer is three: A with B, B with C, and C with A. And between four friends? The answer is *not* four; it is six. You can see this easily if you just draw lines between 4 points. How many links are there between five friends? The answer is 10. You may have noticed that the number of possible links increases much faster than the number of individuals. In fact we can calculate the relationship between nodes and edges using a simple mathematical formula:

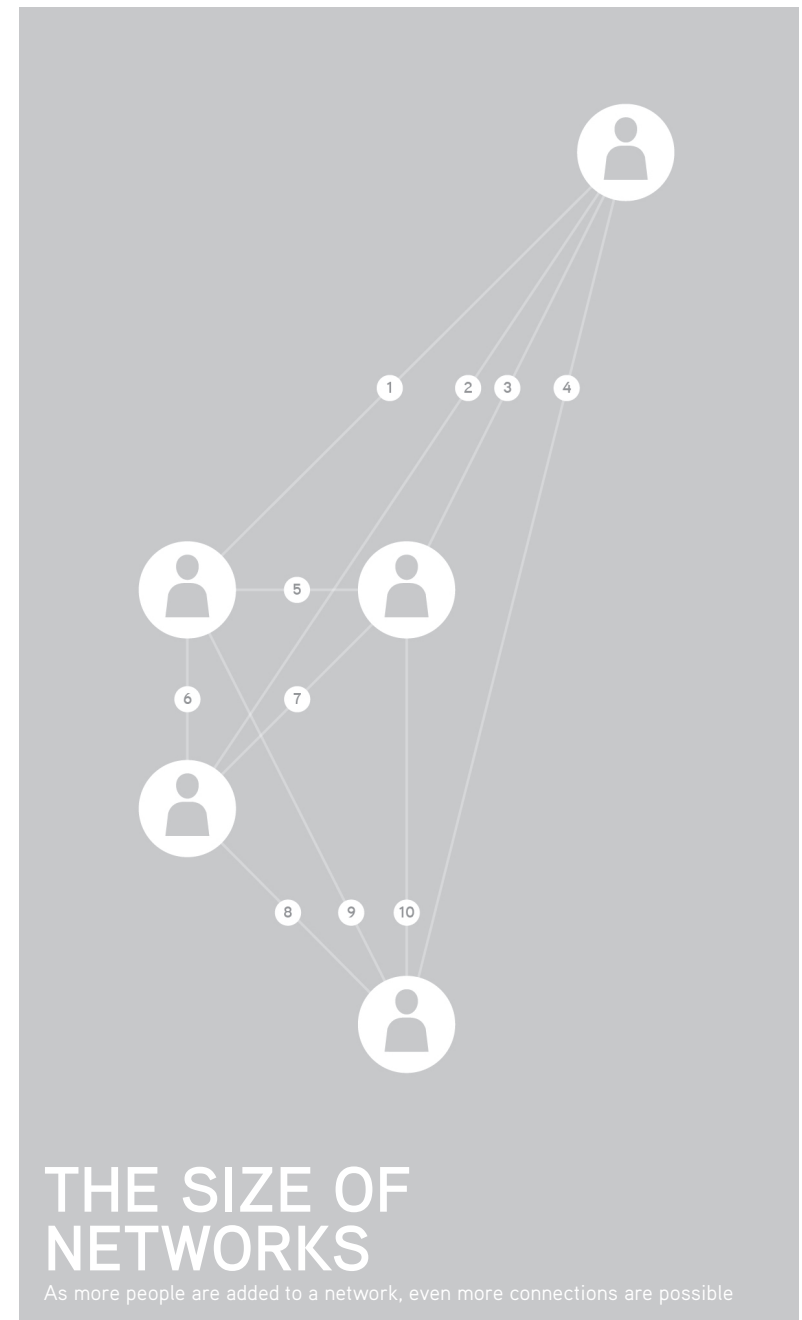
If  $y$  = the number of possible links and  $n$  = the number of people, then

$$y = (n \times (n-1)/2).$$

What this means is that as groups get larger, the number of possible links within the network increases *much* faster than the number of people. This tells us that in large groups, the possibilities for sharing information are much, much greater than in small groups.

This rule may seem pretty abstract, but it is telling us something powerful about the impact of agriculture. Remember that in the Paleolithic era, most communities were tiny, usually with less than 40 or 50 people, though each community normally had a few links with its neighbours. (That is what our diagram tries to show.) But with the appearance of agriculture we suddenly get much larger communities, villages with maybe 500 or perhaps even 2,000 inhabitants. According to our formula, there would be almost 2 million possible links in a community of 2,000 individuals.

$$y = (2,000 \times (2000-1)/2)$$
$$y = 1,999,000$$







Of course, not everybody would link up with everyone else, but this gives you an idea of how fast the possibilities for sharing information within a network can increase as the number of individuals increases.

But that's not all. Each village itself was usually linked to other neighbouring villages, each of which might have lots of inhabitants. And when towns appeared some communities might have 5,000 or even 10,000 people. With a calculator you can use our formula to show that in a community of 10,000 people there are almost 50 million possible links between individuals.

## Rule 1

Here's a simple but interesting rule concerning the size of networks of collective learning:

As the number of connected individuals increases, the number of possible information exchanges between those individuals increases significantly faster, quickly generating more opportunities for collective learning.

or, for short:

**Collective learning increases when more people are connected.**

And larger networks are just what agriculture created! Could this be why, with the rise of agriculture, collective learning seems to have accelerated, generating more ideas and more new ideas much faster than ever before? Those ideas might be about better ways of farming, or better ways of organizing things, or ideas about gods or spirits or neighbors, or they might be pure gossip or powerful stories, and undoubtedly many were lost. But they all arose from the fact that more people were sharing more ideas in more ways.

In the next unit we'll identify some other general rules about how networks and collective learning works and see if those rules can help us make sense of some other large trends in human history.

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